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US5933945: Composite coiled tubing apparatus and methods

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Sorem; Robert , Lawrence, KS

Applicant(s): **Dowell Schlumberger**, Sugar Land, TX

Issued/Filed Dates: **Aug. 10, 1999** / Jan. 26, 1998

Application Number: **US1998000013417**

IPC Class: **H01R 043/00;**

Class: **029/825;** 029/033.F;

Field of Search: **029/825,828,830,33 F**

Abstract: Products and methods relating to composite materials and their use in coiled tubing is disclosed. The composite tubing is a pressurized means of conveying fluids downhole in a wellbore. It comprises a multilayered laminate that resists buckling within the wellbore and is fabricated into a hollow tube. The fibers are oriented in angular relationship to the longitudinal direction of the coiled tubing such as to provide appropriate strength and buckling characteristics to the coiled tubing. Further, the coiled tubing layered laminate may transmit signals representing data from downhole to the surface. In some embodiments, a composite disconnecting means comprised of a blend of fibers of different types or orientations is shown. The disconnecting means shows a failure load range corresponding to the failure characteristics of the fiber blend, the fiber blend having a predetermined failure limit.

Primary/Assistant Examiners: **Arbes; Carl J.**;

Related Applications:

Application Number	ApplDate	Patent	Issued	Title
US1996000593634	1996-01-29			

U.S. References: (No patents reference this one)

Patent	Issued	Inventor(s)	Title

US3949673	4 /1976	Lyerly	Semi-rigid sinuous blasting charge and borehole loading method
US3955878	5 /1976	Nowak	Fiber optic transmission line
US4146302	3 /1979	Jachimowicz	Construction of cable made of optical fibres
US4468088	8 /1984	van der Hoek	Optical telecommunication element

CLAIMS: What is claimed is:
[Hide claims]:

1. A method of conducting coiled tubing operations, comprising:

- providing a composite coiled tubing on a reel having a section modulus varied along its length, the composite coiled tubing having a reel end proximate the reel and a distal end for insertion into a wellbore, the coiled tubing having a section modulus sufficiently low adjacent its reel end to facilitate its spooling on the reel;
- unspooling the composite coiled tubing from the reel; and
- inserting into the wellbore the distal end of the composite coiled tubing, the section modulus of the coiled tubing near its distal end being sufficiently high to resist buckling of the coiled tubing within the wellbore.

2. The method of claim 1 wherein the composite coiled tubing has a longitudinal axis, the composite coiled tubing being comprised of fibers wherein the angle of the fibers relative to the longitudinal axis is varied along the length of the coiled tubing.

3. A method of conducting coiled tubing operations, comprising:

- providing a composite coiled tubing having a hollow wall on a reel, the composite coiled tubing having a reel end proximate the reel and a distal end for insertion into a wellbore, the coiled tubing having a section modulus sufficiently low to facilitate its spooling on the reel;
- positioning metal wires within said wall extending continuously without interruption for a predetermined continuous length of said composite coiled tubing for transmitting signals representing data along said continuous length of said composite coiled tubing;
- positioning a microprocessor in said wall in communication with said metal wires for receiving and transmitting data;
- unspooling the composite coiled tubing from the reel; and
- inserting into the wellbore the distal end of the composite coiled tubing, the section modulus of the coiled tubing being sufficiently high to resist buckling of the coiled tubing within the wellbore.

4. A method of conducting coiled tubing operations, comprising:

- providing a composite coiled tubing having a hollow cylindrical wall formed of a plurality of concentric layers on a reel, the composite coiled tubing having a reel end proximate the reel and a distal end for insertion into a wellbore;

- varying the section modulus of said composite coiled tubing along its length to provide a relatively low section modulus along one predetermined length portion thereof and a relatively high section modulus along another predetermined length portion thereof;
- providing conductive fibers in said wall of said composite coiled tubing extending continuously without interruption for a predetermined continuous length of said composite coiled tubing for conducting signals along the continuous length of said coiled tubing;
- unspooling the composite coiled tubing from the reel; and
- inserting into the wellbore said distal end of the composite coiled tubing, the section modulus of the composite coiled tubing being sufficient to resist buckling of the coiled tubing within the wellbore.

5. The method of claim 4 further including the step of varying the section modulus of the composite coiled tubing along its length, the composite coiled tubing being of sufficiently low section modulus near said reel end to facilitate spooling on the reel and of sufficiently high section modulus near said distal end to resist buckling within the wellbore during coiled tubing operations.

6. The method of claim 5 wherein the step of providing conductive fibers in said wall comprises providing continuous metal wires in said wall for conducting signals along the predetermined continuous length of said composite coiled tubing.

7. The method of claim 6 including the step of providing fatigue detection means downhole to measure wear of the composite coiled tubing downhole to provide signals transmitted by said conductive fibers that represent the condition of the composite coiled tubing at various points along the length of said composite coiled tubing.

8. A method of conducting coiled tubing operations comprising:

- providing a composite coiled tubing having a hollow cylindrical wall formed of a plurality of concentric layers on a reel; the composite coiled tubing having a reel end proximate the reel and a distal end for insertion into a wellbore;
- varying the section modulus of said composite coiled tubing along the length of said coiled tubing to provide a relatively low section modulus along one predetermined length portion thereof and a relatively high section modulus along another predetermined length portion thereof;
- varying the section properties of said composite coiled tubing along said length so that predetermined characteristics of said coiled tubing including stiffness and/or strength thereof may be selectively varied along said length;
- positioning continuous metal wires within said wall extending continuously without interruption for a predetermined continuous length of said composite coiled tubing for conducting signals along said continuous length of said composite coiled tubing;
- positioning a microprocessor in said wall in communication with said metal wires for receiving and transmitting data;
- unspooling the composite coiled tubing from the reel; and
- inserting into the wellbore said distal end of the composite coiled tubing, the section modulus of the coiled tubing being sufficient to resist buckling of the coiled tubing within the

wellbore.

9. The method of claim 8 wherein the step of varying the modulus of the composite coiled along said length includes providing a relatively low section modulus along said reel end to facilitate spooling on the reel and providing a relatively high section modulus along said distal end to resist buckling within the wellbore during coiled tubing operations.

10. The method of claim 8 including the step of providing fatigue detection means downhole to measure wear of the composite coiled tubing downhole to provide signals transmitted by said metal wires that represent the condition of said composite coiled tubing along said length of said composite coiled tubing.

11. The method of claim 8 including the step of transmitting data along said metal wires from said distal end of said composite coiled tubing to said reel end of said composite coiled tubing.

12. The method of claim 8 including the steps of providing one layer of said wall of woven fibers; and

- weaving said metal wires into said one layer.

13. A method of conducting coiled tubing operations, comprising:

- providing a composite coiled tubing formed of a plurality of concentric layers including a combination of fibers and resins of varying strength and orientations mixed into a fiber blend;
- mounting the composite coiled tubing on a reel, the composite coiled tubing having a reel end proximate the reel and a distal end for insertion into a wellbore, the composite coiled tubing having a section modulus sufficient to facilitate spooling of the coiled tubing on the reel;
- unspooling the composite coiled tubing from the reel;
- inserting into the wellbore said distal end of the composite coiled tubing, the section modulus of the composite coiled tubing being sufficient to resist buckling of the coiled tubing within the wellbore;
- varying the section modulus along the length of the composite coiled tubing, the composite coiled tubing being of a relatively low section modulus along one predetermined length portion thereof and of a relatively high section modulus along another predetermined length portion thereof; and
- providing a composite tubing disconnect at a predetermined location of the composite coiled tubing where the load range at which the composite tubing disconnect fails corresponds to the failure characteristics of said fiber blend, the fiber blend having a predetermined failure limit.

14. The method as set forth in claim 13 including the steps of:

- providing conductive fibers within said composite coiled tubing for transmitting signals representing data; and
- positioning fatigue detection means downhole to measure wear of said composite coiled tubing downhole to provide signals transmitted by said conductive fibers that represent the condition of the composite coiled tubing at various points along said length of said composite coiled tubing.

15. The method as set forth in claim 13 including the steps of:

- providing one layer of said wall of woven fibers; and
- weaving conductive metal wires within said one layer for transmitting data along said metal wires from said distal end of said composite coiled tubing to said reel end of said composite coiled tubing.

16. A method of conducting coiled tubing operations, comprising:

- providing a composite coiled tubing on a reel, the composite coiled tubing having a reel end proximate the reel and a distal end for insertion into a wellbore;
- varying the section modulus along the length of said composite coiled tubing to provide a relatively low section modulus along one predetermined length portion thereof and a relatively high section modulus along another predetermined length portion thereof;
- varying the section properties along the length of said composite coiled tubing so that predetermined characteristics of said coiled tubing including stiffness and/or strength thereof may be selectively varied along said length;
- unspooling the composite coiled tubing from the reel; and
- inserting into the wellbore said distal end of the composite coiled tubing.

This application is a division of Ser. No. 08/593,634, filed Jan. 29, 1996.

Foreign References: **none**

(No patents reference this one)

US5828003: Composite coiled tubing apparatus and methods

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Application Number: **US1996000593634**

IPC Class: **H01B 007/06;**

Class: **Current:** 174/069; 138/123; 138/137;
Original: **174/069;** 138/123; 138/137;

Field of Search: **174/47,68.1,70 R,71 R,64,67,106 R,69 138/123-125,137**

Abstract: Products and methods relating to composite materials and their use in coiled tubing is disclosed. The composite tubing is a pressurized structure for conveying fluids downhole in a wellbore. It has a multilayered laminate that resists buckling within the wellbore and is fabricated into a hollow tube. The fibers are oriented in angular relationship to the longitudinal direction of the coiled tubing such as to provide appropriate strength and buckling characteristics to the coiled tubing. Further, the coiled tubing layered laminate may transmit signals representing data from downhole to the surface. In some embodiments, a composite disconnecting structure having a blend of fibers of different types or orientations is shown. The disconnecting structure shows a failure load range corresponding to the failure characteristics of the fiber blend, the fiber blend having a predetermined failure limit.

Attorney, Agent, or Firm: **Vick, Jr.; John E.;**

Primary/Assistant Examiners: **Kincaid; Kristine L.**; Patel; Dhiru R.

U.S. References: (No patents reference this one)

Patent	Issued	Inventor(s)	Title
US4336415	6 /1982	Walling	Flexible production tubing

US4374530	2 /1983	Walling	Flexible production tubing
US4446892	5 /1984	Maxwell	Method and apparatus for monitoring lengths of hose
US4465105	8 /1984	Slater	Flexible hose
US4554650	11 /1985	Brown et al.	Oil filled towed array hose without couplings
US4570705	2 /1986	Walling	Sheave drive assembly for flexible production tubing
US4940095	7 /1990	Newman	Deployment/retrieval method and apparatus for well tools used with coiled tubing
US5025861	6 /1991	Huber	Tubing and wireline conveyed perforating method and apparatus
US5048441	9 /1991	Quigley	Composite sail mast with high bending strength
US5097870	3 /1992	Williams	Composite tubular member with multiple cells
US5285008	2 /1994	Sas-Jaworsky et al.	Spoolable composite tubular member with integrated conductors
US5285204	2 /1994	Sas-Jaworsky et al.	Coil tubing string and downhole generator
US5469916	11 /1995	Sas-Jaworsky et al.	System for depth measurement in a wellbore using composite coiled tubing
US5494105	2 /1996	Morris	Method and related system for operating a downhole tool

CLAIMS: What is claimed is:

[Hide claims]: 1. A composite coiled tubing of a hollow cylindrical cross section, comprising:

- an outer cylindrical surface layer;
- a cylindrical composite fiber layer, wherein the composite fiber layer is concentrically inside of the surface layer to form with said outer layer a circumferential wall about the hollow coiled tubing, the composite fiber layer formed in part by weaving composite fibers in a predetermined pattern whereby the woven fibers are oriented in relationship to the longitudinal direction of the coiled tubing such as to provide appropriate strength and buckling characteristics to the coiled tubing; and
- conductive fibers in said wall of said hollow composite coiled tubing extending continuously without interruption for a predetermined continuous length of said coiled tubing for conducting signals along the continuous length of said coiled tubing; said coiled tubing having a section modulus and section properties which vary along the length of the coiled tubing so that predetermined characteristics of said coiled tubing including stiffness or strength thereof may be varied.

2. The composite coiled tubing of claim 1 wherein said conductive fibers comprise continuous metal wires.

3. The composite coiled tubing of claim 2 wherein the composite fiber layer includes said conductive fibers.

4. The composite coiled tubing of claim 3 wherein the conductive fibers are radioactive fibers.

5. The composite coiled tubing of claim 4 wherein the conductive fibers are adapted to conduct electrical signals in response to magnetic fluctuations.

6. The composite coiled tubing of claim 4 wherein the conductive fibers are adapted to conduct light signals.

7. The composite coiled tubing of claim 4 wherein the conductive fibers are adapted to transmit signals that represent data.

8. The composite coiled tubing of claim 7 wherein the conductive fibers facilitate monitoring the coiled tubing for structural integrity.

9. The composite coiled tubing of claim 7 wherein the conductive fibers facilitate remote operation of tools.

10. The composite coiled tubing of claim 1 further comprising a cylindrical liner layer concentrically inside the composite fiber layer.

11. A composite coiled tubing comprising:

- a cylindrical surface layer;
- a cylindrical composite fiber layer, wherein the composite fiber layer is concentrically inside of the surface layer, the composite fiber layer formed by weaving composite fibers in a predetermined pattern whereby the fibers are oriented in angular relationship to the longitudinal direction of the coiled tubing such as to provide appropriate strength and buckling characteristics to the coiled tubing;
- said coiled tubing having a section modulus and section properties which vary along the length of the coiled tubing so that predetermined characteristics of said coiled tubing including stiffness or strength thereof may be selectively varied,
- a cylindrical liner layer concentrically inside the composite fiber layer;
- further wherein conductive fibers are provided within the composite coiled tubing extending continuously along said coiled tubing, the fibers being adapted to transmit signals representing data along said coiled tubing.

12. The coiled tubing of claim 11 wherein the composite coiled tubing additionally comprises a microprocessor in the composite coiled tubing.

13. A composite coiled tubing of a hollow cylindrical cross section, comprising:

- an inner cylindrical liner layer;
- an outer cylindrical composite fiber layer in concentric relation to said inner liner layer to form with said inner liner layer a circumferential wall defining said hollow cylindrical cross section of said coiled tubing, the composite fiber layer formed in part by woven fibers in a predetermined pattern whereby the woven fibers are oriented in relationship to the longitudinal direction of the coiled tubing such as to provide appropriate strength and buckling characteristics to the coiled

tubing;

- conductive metal wire in said circumferential wall extending continuously without interruption for a predetermined continuous length of said coiled tubing for conducting signals along said coiled tubing;
- said coiled tubing having a predetermined section modules and section properties which vary along the length of the coiled tubing so that predetermined characteristics of said coiled tubing including stiffness or strength thereof may be selectively varied; and
- a microprocessor positioned in said circumferential wall and in communication with said metal wires for receiving and transmitting data.

14. The composite coiled tubing as set forth in claim 13 wherein said composite coiled tubing has a reel end proximate to a reel for the composite coiled tubing and a distal end for insertion within a wellbore, said section modulus of the composite coiled tubing being sufficiently low near said reel end to facilitate spooling on the reel and being sufficiently high near said distal end to resist buckling within the wellbore during coiled tubing operations.

15. The composite coiled tubing as set forth in claim 14 wherein said woven fibers are oriented such that the modulus and strength of the composite coiled tubing is dependent upon fiber properties and the orientation of the woven fibers.

16. The composite coiled tubing as set forth in claim 15 wherein the angle formed by the woven fibers as compared to the longitudinal direction of the coiled tubing varies along the length of the coiled tubing for varying the strength and buckling resistance of the coiled tubing correspondingly.

17. A composite coiled tubing as set forth in claim 14 wherein a composite disconnect is provided at a predetermined location on the composite coiled tubing, said disconnect including a combination of fibers and resins of varying strength and orientations mixed into a fiber blend, wherein a load at which the composite disconnect fails corresponds to the failure characteristics of the fiber blend, the fiber blend having a predetermined failure limit.

18. A composite coiled tubing of a hollow cylindrical cross section, comprising:

- an outer cylindrical liner layer;
- a cylindrical composite fiber layer, wherein the composite fiber layer is concentrically inside of the surface layer to form with said outer layer a circumferential wall about the hollow coiled tubing, the composite fiber layer formed in part by weaving composite fibers in a predetermined pattern, the woven fibers oriented in relationship to the longitudinal direction of the coiled tubing and the angles formed by said woven fibers as compared to the longitudinal direction of the coiled tubing varying along the length of the coiled tubing for varying correspondingly the strength and bending modulus of the coiled tubing;
- conductive fibers in said wall of said hollow composite coiled tubing extending continuously without interruption for a predetermined continuous length of said coiled tubing for conducting signals along the continuous length of said coiled tubing; said coiled tubing having a predetermined section modules and section properties which may vary along the

length of the coiled tubing so that predetermined characteristics of said coiled tubing including stiffness or strength thereof may be selectively controlled;

- said composite coiled tubing having to a reel end proximate a reel for the composite coiled tubing and a distal end attached to a tool for insertion within a wellbore; and a disconnect for the composite coiled tubing at a predetermined position along the length of said coiled tubing and a plurality of fibers of varying strength and orientation mixed into a fiber blend wherein a load at which the composite disconnect fails correspond to the failure characteristics of the fiber blend.

19. The composite coiled tubing as set forth in claim 18 wherein:

- fatigue detection means is provided to measure wear of the coiled tubing to provide said signals transmitted by said conductive fibers that represent the condition of the coiled tubing at various points along the length of said coiled tubing.

20. The composite coiled tubing as set forth in claim 18 wherein a microprocessor is positioned in said circumferential wall for communication with said conductive fibers for receiving and transmitting data.

Foreign References: **none**

(No patents reference this one)

Other References:

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- A. Sas-Jaworski & J.G. Williams, "Enabling Capabilities And Potential Applications of Composite Coiled Tubing", Mar. 29-31, 1994, 2nd Annual World Oil Coiled Tubing Conference & Exhibition, Houston, Texas.
- D. Bigio, A. Rike, A. Christensen, J. CollinsD. Hardman, D. Doremus, P. Tracy, G. Glass, N.B. Joergensen, D. Stephens, "Coiled Tubing Takes Center Stage", Oct., 1994, Oilfield Review, pp. 9-23.
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- S.S. Wang & D.W. Fitting, "Composit Materials for Offshore Operations: Proceedings of the First International Workshop", Houston, Texas, Oct., 1993, NIST Special Publication 887.

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